

# **6.S196 / PPAT: Principles and Practice of Assistive Technology**

Today: Functional Deficits  
that Accompany Aging

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## Changes Associated with Aging

- Physical
  - Skin, hair, height, weight, speed, strength
  - Decreased night vision, lung capacity, gait speed
- Sensory/perceptual
  - Hearing, vision, touch, proprioceptive, kinesthetic
- Cognitive
  - Memory, speed, dementia, psychological
- Social
  - Reduced participation, increased dependence

## Sensory/Perceptual Function

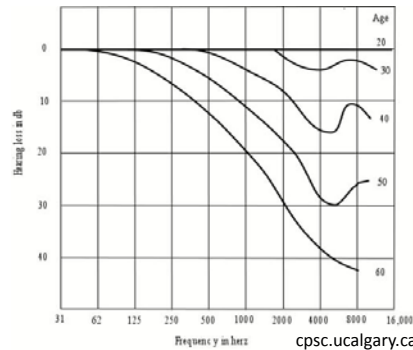
- Hearing
- Vision
- Taste
- Smell
- Touch
- Proprioception
- Kinesthetic sense

## Hearing Impairment

- Common causes
  - Deterioration of inner ear mechanisms
  - Persistent/traumatic exposure to loud noises
  - Some medications (e.g. painkillers, antibiotics)
  - Insufficient nutrients in diet
  - Genetic factors

## Manifestations

- Loss of response at high frequencies
  - Typically ~40 dB at 8 KHz by age 60



- Distortion hinders speech understanding
  - Especially on telephone, or out of line of sight

## Technological/contextual aids

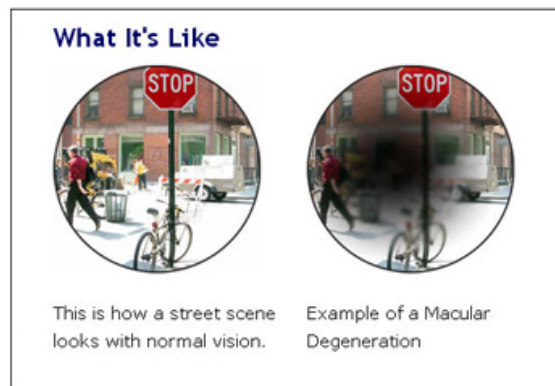
- Hearing aid / cochlear implant
  - Differential frequency response, amplification
  - Signal processing for frequency compression
- Accommodation by speech partners
  - Speak with greater volume (without shouting)
  - Try to use a lower pitch when speaking
  - Articulate speech sounds more clearly
  - Speak from within listener's field of vision
  - Speak slowly, enabling listener to grasp intent

# Vision Impairment

- Common causes
  - Age-related macular degeneration
  - Cataracts
  - Diabetic retinopathy
  - Glaucoma

## Age-Related Macular Degeneration

- Loss of light-sensitive cells in macula



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# Cataracts

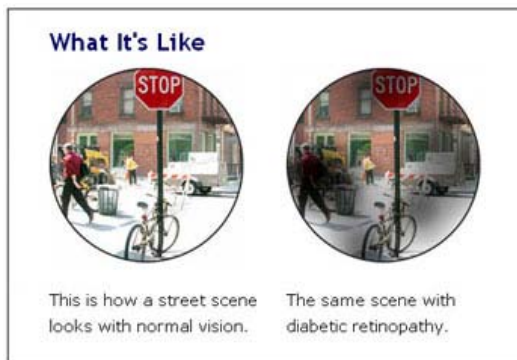
- Clouding of lens of one or both eyes



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# Diabetic Retinopathy

- Complication of diabetes (insufficient regulation of blood insulin, glucose)
  - Interference with functional tissues of retina



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# Glaucoma

- Excessive fluid pressure damages optic nerve
  - Blur, halos, blank spots, loss of peripheral vision



- Symptoms develop gradually, can be hard to notice

## Technological/contextual aids

- AT devices for low vision
  - Lighting, magnification, contrast enhancement
  - Optical character recognition, speech synthesis
- Retinal / occipital cortex implants
  - Still in experimental stage
- Facilitation by partners/caregivers
  - Awareness of functional regions of visual field
  - Awareness of visual system effective resolution
  - Arrange lighting, presentation to suit abilities
  - Accompaniment by audible/tactile stimuli

## Mobility and Manipulation

- Deficits in proprioception
  - Problems with balance, dizziness
  - Slower reaction times, less effective reflexes
  - Gait abnormalities, increased fall risk
- Deficits in fine manipulation
  - Higher thresholds for touch, pain sensitivity
  - Slower nerve conduction speeds, less dexterity
- Declining strength and endurance
  - Implications for physically demanding tasks

## Top Fall Risks (Anderson, 2004)

Primary accidental cause of death for those 65 and over!  
(Increases in winter due to ice/darkness, but most falls are indoors.)

- 1) Stairs (especially those without handrails)
- 2) Footwear providing poor traction
- 3) Standing on chairs or other objects to extend reach
- 4) Furniture that obstructs path
- 5) Throw rugs that slip when walked upon
- 6) Narrow and/or twisting passages
- 7) Non-furniture obstacles (cords, clothes, shoes, clutter)
- 8) Dim or insufficient lighting
- 9) Lack of traction strips in bathtub/shower

Anderson, Fear of falling: senior citizens face serious injury, death from losing their balance. Atlanta Journal-Constitution, 6 Jan 2004.

## Mitigating Fall Risks (Enix et al. 2011)

Orthostatic hypotension	Rise slowly after sitting
Postprandial hypotension	Evaluate carbohydrate intake
Low back pain	Chiropractic care/physical therapy
Muscle weakness	Exercise, tai chi, yoga, walking
Balance problems	Fall exam, walker, 3-point cane
Transferring to bed, toilet, couch	Lower bed/raise toilet, add railings, lift
Lighting, clutter, stairs, slippers	Home inspection/Occupational therapy
Medication-increased fall risk	Review medications, like psychotropics
Fear of falls/loss of independence	Medic-Alert pendant/bracelet

Enix et al., Balance Problems in the Geriatric Patient,  
*Topics in Integrative Health Care* 2011, Vol. 2(1)

CDC, Injury Prevention & Control: Home and Recreational Safety  
<http://www.cdc.gov/homeandrecreationalafety/falls/index.html>

## Cognitive Deficits

- Impaired senses of hearing, vision, touch
- Vulnerability to poor aural/visual conditions
- Slower reaction/response times
- Declines in sustained attention
- Less effective working memory, recall
- Difficulty with multi-tasking
- Difficulty learning new routines
- Difficulty identifying salient information



## Dementia

- Majority of cases due to Alzheimer's disease
  - Plaques and tangles in neural tissue
  - About 6-8% of those over 65 affected
  - More than 30% of those over 85 affected
- Symptoms
  - Wandering/getting lost, memory loss, poor personal hygiene, failure to take meds
  - However many with dementia can orient to place, person and time into advanced stages

## Personal/Societal Costs

- Decreased quality of life
  - Loss of independence in activities of daily living
  - Loss of privacy (family, outside caregivers)
- Associated costs (est. \$100B annually in US)
  - Family caregivers: lost wages, opportunities
  - Non-family caregivers: wages
- Implications when receiving medical care
  - Difficulty giving medical history information
  - Difficulty following medical recommendations

## Technological/contextual aids

- Medical (some reversible/treatable causes)
  - Thyroid; B12 deficit; sensory deficit; depression
- Wander detection / navigation aids
  - Alert to caregivers (e.g. MIT system at TBH)
  - Prompted/unprompted guidance “home”
- Cognitive aids for sequencing tasks
  - Daily routines, medical regimens, etc.
  - Independent validation is challenging

## Conclusion

- Aging tends to bring a mix of impairments
  - Sensory, motor, cognitive, psychosocial
- Variety of mitigating strategies
  - Contextual: lighting, physical modifications
  - Technical: hearing aids, vision enhancements
  - Caregiver: prompting, assistance with ADLs
- Ripe area for development of novel AT
  - Use of machine sensing, mobility, manipulation
  - Very challenging: safety, abandonment, social
- Pressing problem: demographics to 2100